

Claims

WHAT IS CLAIMED IS:

1. A method comprising:

evaluating network capacity available for communications between a first node and a second node based on transfer data received by the second node from the first node within a specified receive window during a specified control interval; and

generating an adjusted receive window size for a subsequent control interval based on evaluated availability of the network capacity in the specified control interval.

2. The method of claim 1 further comprising:

communicating the adjusted receive window size to the first node to instruct the first node to transmit to the second node in accordance with the adjusted receive window size in the subsequent control interval.

3. The method of claim 1 wherein the operation of generating comprises:

adjusting a receive buffer size at the second node at an application level to generate the adjusted window size in the subsequent control interval.

4. The method of claim 1 wherein the operation of generating comprises:

adjusting a receive buffer size at the second node to generate the adjusted window size in the subsequent control interval.

1 5. The method of claim 1 wherein the operation of generating comprises:
2 applying the adjusted window size to a transport level of the receive node
3 in the subsequent control interval.

4 6. The method of claim 1 wherein the operation of generating comprises:
5 applying the adjusted window size to a transport level of the receive node
6 in the subsequent control interval.

7 7. The method of claim 1 further comprising:
8 communicating the adjusted receive window size to the first node to
9 instruct the first node to adjust a send window size in accordance with the receive
10 window and to transmit to the second node in accordance with the adjusted receive
11 window size in the subsequent control interval.

12 8. The method of claim 1 wherein the operation of evaluating comprises:
13 detecting a loss of the transfer data received by the second node during the
14 specified control interval, relative to the specified receive window.

15 9. The method of claim 1 wherein the operation of evaluating comprises:
16 measuring an amount of the transfer data received by the second node
17 during the specified control interval.

18 10. The method of claim 1, wherein the operation of generating comprises:
19 determining whether to increase or decrease the receive window to obtain
20 the adjusted receive window size; and
21 determining an amount by which to adjust the receive window to obtain the

22 adjusted receive window size.
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1 11. The method of claim 1 wherein the operation of generating comprises:
2 determining an amount by which to adjust the receive window using a
3 binary search to obtain the adjusted receive window size.

4 12. The method of claim 1 wherein the operation of generating comprises:
5 determining an amount by which to adjust the receive window using a
6 stochastic approximation to obtain the adjusted receive window size.

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8 13. The method of claim 1 wherein the operation of generating comprises:
9 evaluating a measured amount of the transfer data received by the receiver
10 node during the specified control interval relative to the specified received
11 window size to determine a slope for the specified control interval; and
12 testing the slope for the specified control interval against an estimate of a
13 constant slope associated with additional available network capacity in at least one
14 previous control interval.

15 14. The method of claim 1 wherein the operation of generating comprises:
16 evaluating a measured amount of the transfer data received by the receiver
17 node during the specified control interval relative to the specified received
18 window size to determine a slope for the specified control interval; and
19 testing the slope for the specified control interval against an estimate of a
20 constant slope associated with additional available network capacity in at least one
21 previous control interval in the presence of a measurement noise threshold.
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1 15. The method of claim 1 wherein the operation of generating comprises:
2 evaluating a measured amount of the transfer data received by the receiver
3 node during the specified control interval relative to the specified received
4 window size to determine a slope for the specified control interval; and
5 testing the slope for the specified control interval against an estimate of a
6 constant slope associated with additional available network capacity in at least one
7 previous control interval, wherein the estimate of the constant slope represents a
8 weighted average of at least one previous slopes associated with at least one
9 previous control interval in which the previous slope exceeds or equals a previous
10 estimate of the constant slope.

11 16. The method of claim 1 wherein the operations of evaluating and
12 generating are performed at the application level.
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1 17. A computer program product encoding a computer program for
2 executing on a computer system a computer process, the computer process
3 comprising:

4 evaluating network capacity available for communications between a first
5 node and a second node based on transfer data received by the second node from
6 the first node within a specified receive window during a specified control
7 interval; and

8 generating an adjusted receive window size for a subsequent control
9 interval based on evaluated availability of the network capacity in the specified
10 control interval.

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12 18. The computer program product of claim 17 wherein the computer
13 process further comprises:

14 communicating the adjusted receive window size to the first node to
15 instruct the first node to transmit to the second node in accordance with the
16 adjusted receive window size in the subsequent control interval.

17 19. The computer program product of claim 17 wherein the operation of
18 generating comprises:

19 adjusting a receive buffer size at the second node at an application level to
20 generate the adjusted window size in the subsequent control interval.

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22 20. The computer program product of claim 17 wherein the operation of
23 generating comprises:

24 adjusting a receive buffer size at the second node to generate the adjusted
25 window size in the subsequent control interval.

1 21. The computer program product of claim 17 wherein the operation of
2 generating comprises:

3 applying the adjusted window size to a transport level of the receive node
4 in the subsequent control interval.

5 22. The computer program product of claim 17 wherein the operation of
6 generating comprises:

7 applying the adjusted window size to a transport level of the receive node
8 in the subsequent control interval.

9 23. The computer program product of claim 17 the computer process further
10 comprises:

11 communicating the adjusted receive window size to the first node to
12 instruct the first node to adjust a send window size in accordance with the receive
13 window and to transmit to the second node in accordance with the adjusted receive
14 window size in the subsequent control interval.
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16 24. The computer program product of claim 17 wherein the operation of
17 evaluating comprises:

18 detecting a loss of the transfer data received by the second node during the
19 specified control interval, relative to the specified receive window.
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21 25. The computer program product of claim 17 wherein the operation of
22 evaluating comprises:

23 measuring an amount of the transfer data received by the second node
24 during the specified control interval.
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1 26. The computer program product of claim 17 wherein the operation of
2 generating comprises:
3 determining whether to increase or decrease the receive window to obtain
4 the adjusted receive window size; and
5 determining an amount by which to adjust the receive window to obtain the
6 adjusted receive window size.

7 27. The computer program product of claim 17 wherein the operation of
8 generating comprises:
9 determining an amount by which to adjust the receive window using a
10 binary search to obtain the adjusted receive window size.

11 28. The computer program product of claim 17 wherein the operation of
12 generating comprises:
13 determining an amount by which to adjust the receive window using a
14 stochastic approximation to obtain the adjusted receive window size.

15 29. The computer program product of claim 17 wherein the operation of
16 generating comprises:
17 evaluating a measured amount of the transfer data received by the receiver
18 node during the specified control interval relative to the specified received
19 window size to determine a slope for the specified control interval; and
20 testing the slope for the specified control interval against an estimate of a
21 constant slope associated with additional available network capacity in at least one
22 previous control interval.
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1 30. The computer program product of claim 17, wherein the operation of
2 generating comprises:

3 evaluating a measured amount of the transfer data received by the receiver
4 node during the specified control interval relative to the specified received
5 window size to determine a slope for the specified control interval; and

6 testing the slope for the specified control interval against an estimate of a
7 constant slope associated with additional available network capacity in at least one
8 previous control interval in the presence of a measurement noise threshold.

9 31. The computer program product of claim 17 wherein the operation of
10 generating comprises:

11 evaluating a measured amount of the transfer data received by the receiver
12 node during the specified control interval relative to the specified received
13 window size to determine a slope for the specified control interval; and

14 testing the slope for the specified control interval against an estimate of a
15 constant slope associated with additional available network capacity in at least one
16 previous control interval, wherein the estimate of the constant slope represents a
17 weighted average of at least one previous slopes associated with at least one
18 previous control interval in which the previous slope exceeds or equals a previous
19 estimate of the constant slope.

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21 32. The computer program product of claim 17 wherein the operations of
22 evaluating and generating are performed at the application level.
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1 33. A system comprising:
2 an estimating module evaluating network capacity available for
3 communications between a first node and a second node based on transfer data
4 received by the second node from the first node within a specified receive window
5 during a specified control interval; and

6 an adjusting module generating an adjusted receive window size for a
7 subsequent control interval based on evaluated availability of the network capacity
8 in the specified control interval.

9 34. The system of claim 33 further comprising:
10 a communication module communicating the adjusted receive window size
11 to the first node to instruct the first node to transmit to the second node in
12 accordance with the adjusted receive window size in the subsequent control
13 interval.
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15 35. The system of claim 33 wherein the adjusting module adjusts a receive
16 buffer size at the second node at an application level to generate the adjusted
17 window size in the subsequent control interval.
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19 36. The system of claim 33 wherein the adjusting module adjusts a receive
20 buffer size at the second node to generate the adjusted window size in the
21 subsequent control interval.

22 37. The system of claim 33 wherein the adjusting module applies the
23 adjusted window size to a transport level of the receive node in the subsequent
24 control interval.
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1 38. The system of claim 33 wherein the adjusting module applies the
2 adjusted window size to a transport level of the receive node in the subsequent
3 control interval.

4 39. The system of claim 33 further comprising:
5 a communications module communicates the adjusted receive window size
6 to the first node to instruct the first node to adjust a send window size in
7 accordance with the receive window and transmits to the second node in
8 accordance with the adjusted receive window size in the subsequent control
9 interval.

10 40. The system of claim 33 wherein the estimating module detects a loss of
11 the transfer data received by the second node during the specified control interval,
12 relative to the specified receive window.
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14 41. The system of claim 33 wherein the estimating module measures an
15 amount of the transfer data received by the second node during the specified
16 control interval.
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18 42. The system of claim 33 wherein the adjusting module determines
19 whether to increase or decrease the receive window to obtain the adjusted receive
20 window size and determines an amount by which to adjust the receive window to
21 obtain the adjusted receive window size.

22 43. The system of claim 33 wherein adjusting module determines an
23 amount by which to adjust the receive window using a binary search to obtain the
24 adjusted receive window size.
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1 44. The system of claim 33 wherein the adjusting module determines an
2 amount by which to adjust the receive window using a stochastic approximation to
3 obtain the adjusted receive window size.

4 45. The system of claim 33 wherein the adjusting module evaluates a
5 measured amount of the transfer data received by the receiver node during the
6 specified control interval relative to the specified received window size to
7 determine a slope for the specified control interval; and

8 testing the slope for the specified control interval against an estimate of a
9 constant slope associated with additional available network capacity in at least one
10 previous control interval.

11 46. The system of claim 33 wherein the adjusting module evaluates a
12 measured amount of the transfer data received by the receiver node during the
13 specified control interval relative to the specified received window size to
14 determine a slope for the specified control interval and tests the slope for the
15 specified control interval against an estimate of a constant slope associated with
16 additional available network capacity in at least one previous control interval in
17 the presence of a measurement noise threshold.

18 47. The system of claim 33 wherein adjusting module evaluates a measured
19 amount of the transfer data received by the receiver node during the specified
20 control interval relative to the specified received window size to determine a slope
21 for the specified control interval and tests the slope for the specified control
22 interval against an estimate of a constant slope associated with additional available
23 network capacity in at least one previous control interval, wherein the estimate of
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1 the constant slope represents a weighted average of at least one previous slopes
2 associated with at least one previous control interval in which the previous slope
3 exceeds or equals a previous estimate of the constant slope.

4 48. The system of claim 33 wherein the estimating module and the adjusting
5 module operate at the application level.
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